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Dendi

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[54] **SYSTEM AND METHOD FOR SAFELY AND EFFICIENTLY REDIRECTING A TELEPHONE CALL**

[75] Inventor: **Ranga R. Dendi**, Plano, Tex.

[73] Assignee: **MCI Corporation**, Washington, D.C.

[21] Appl. No.: **654,178**

[22] Filed: **May 28, 1996**

[51] **Int. Cl.**[6] **H04M 7/00**; H04J 1/16; H04J 3/14

[52] **U.S. Cl.** **379/221**; 370/217; 370/385; 379/230

[58] **Field of Search** 379/219, 220, 379/221, 229, 230, 269, 279; 370/217, 225

[56] **References Cited**

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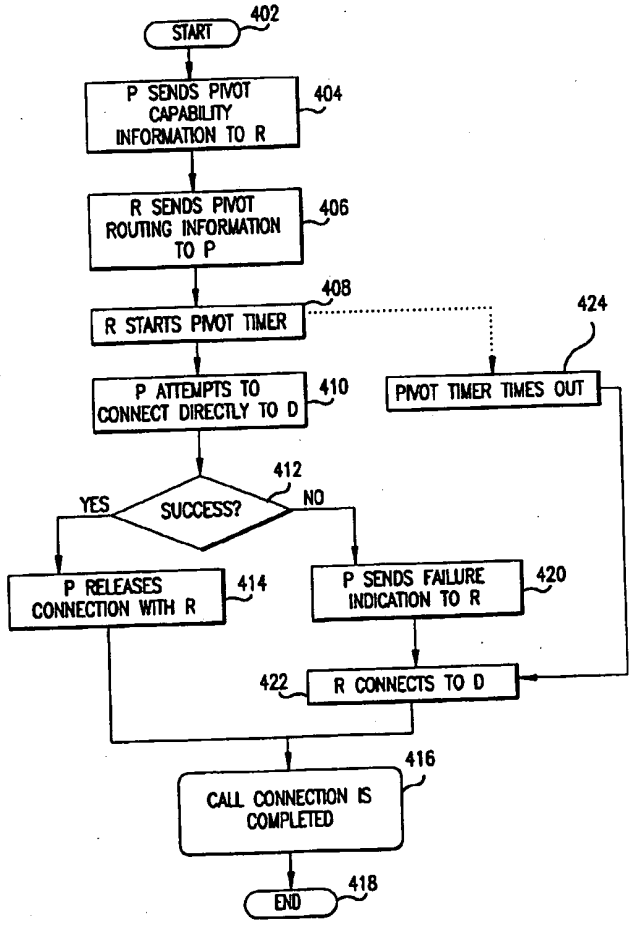
Primary Examiner—Harry S. Hong

[57] **ABSTRACT**

A system and method for efficient routing of communication paths in a telecommunications system. The system comprises a telecommunications network having a pivot node, a destination node, and a release node connected to the pivot node and having a possible connection to the destination node. The method includes attempting to establish a direct connection between the destination node and the pivot node. An attempt is initially made to establish a direct connection between the destination node and the pivot node. If the destination node and the pivot node can be connected directly, then the connection between the pivot node and the release node is released. If the attempt to directly connect the destination node and the pivot node fails, a direct connection is established between the destination node and the release node. The failure to connect the destination node and the pivot node can be indicated by two methods. In the pivot method, the pivot node sends a failure indication to the release node. In the destination method, a timer is started in the release node when the connection attempt begins; the expiration of the timer indicates failure.

12 Claims, 8 Drawing Sheets



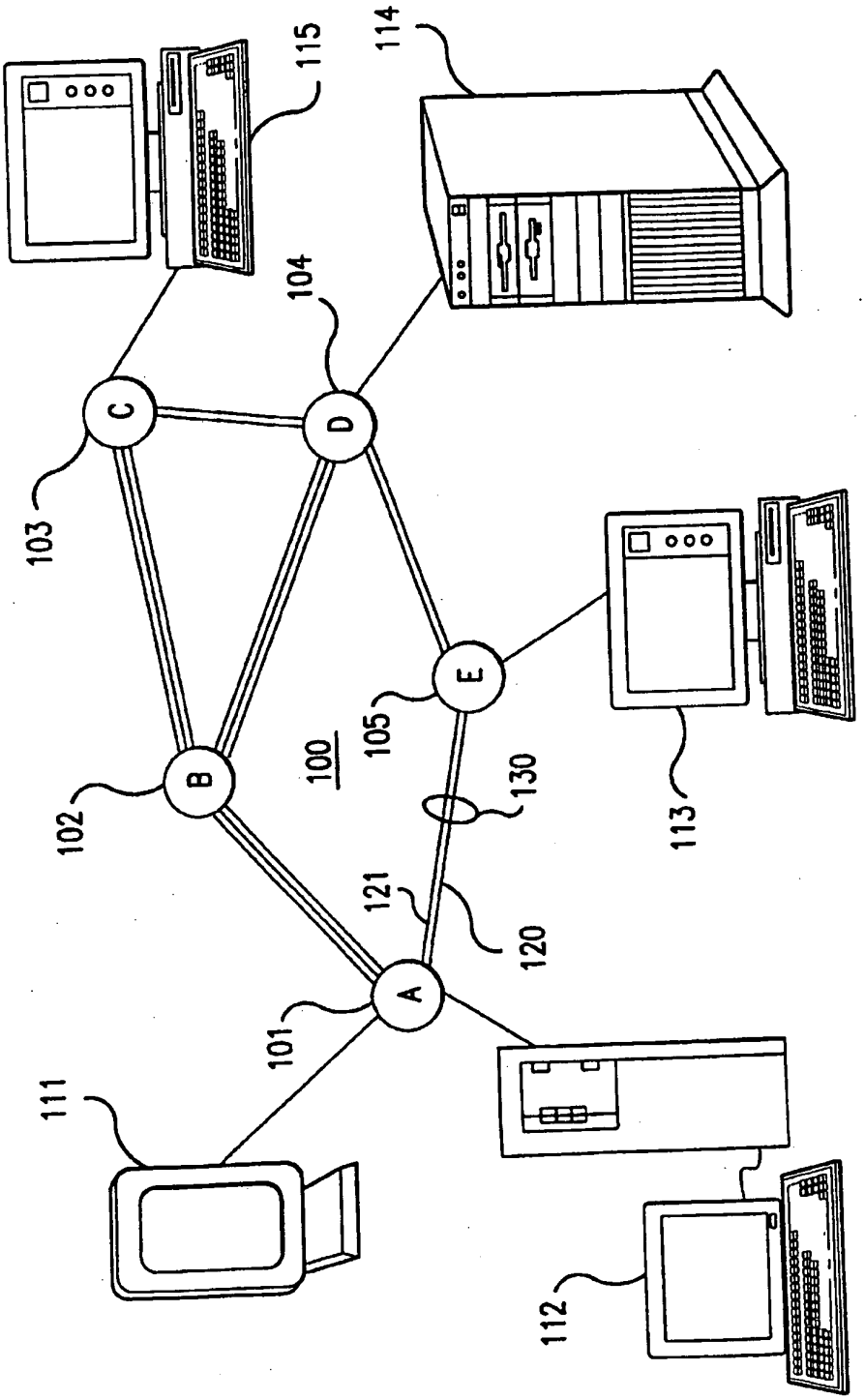


FIG. 1

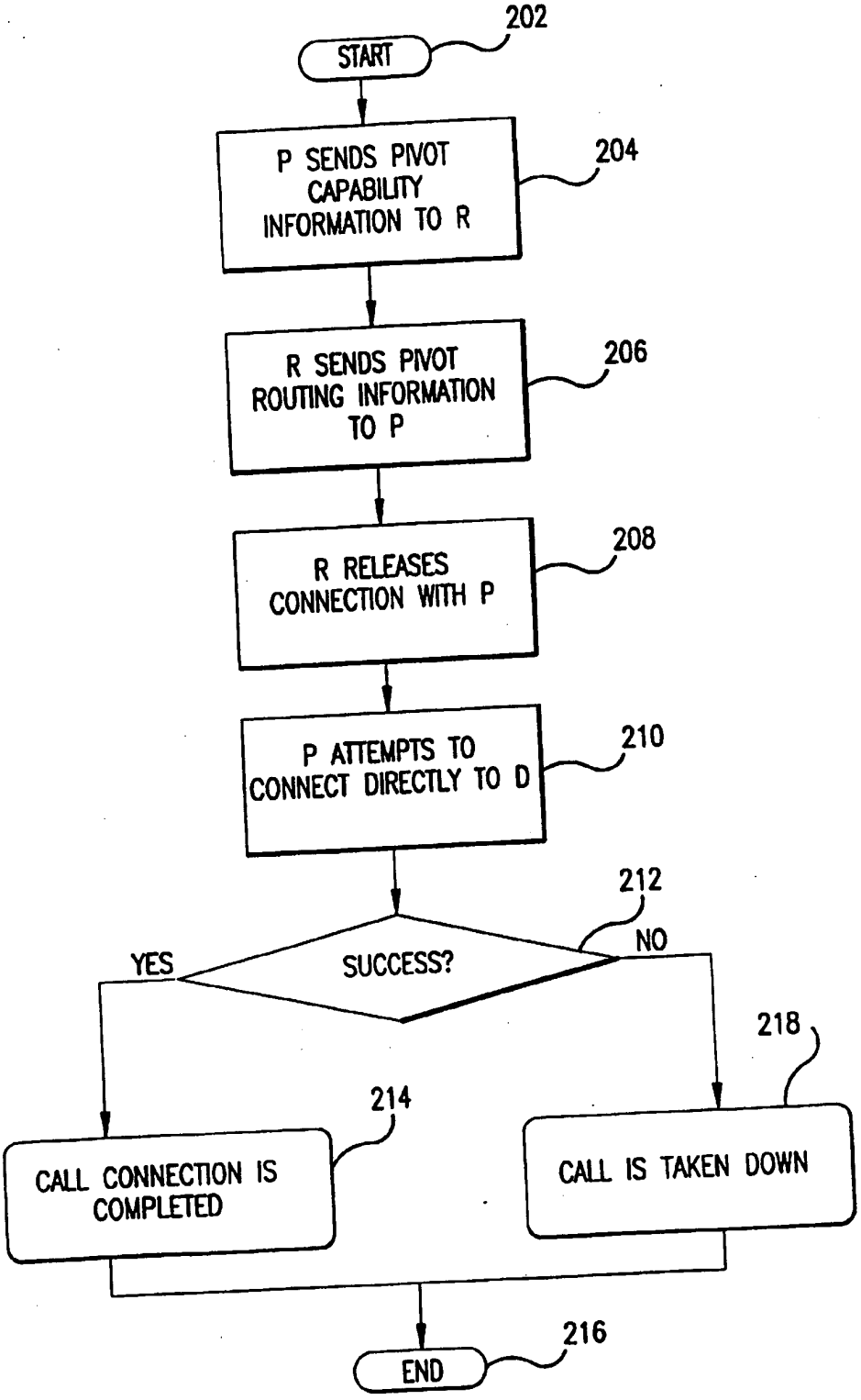

202
START
P SENDS PIVOT CAPABILITY INFORMATION TO R
204
R SENDS PIVOT ROUTING INFORMATION TO P
206
R RELEASES CONNECTION WITH P
208
P ATTEMPTS TO CONNECT DIRECTLY TO D
210
212
SUCCESS?
YES
NO
214
CALL CONNECTION IS COMPLETED
218
CALL IS TAKEN DOWN
216
END

FIG.2

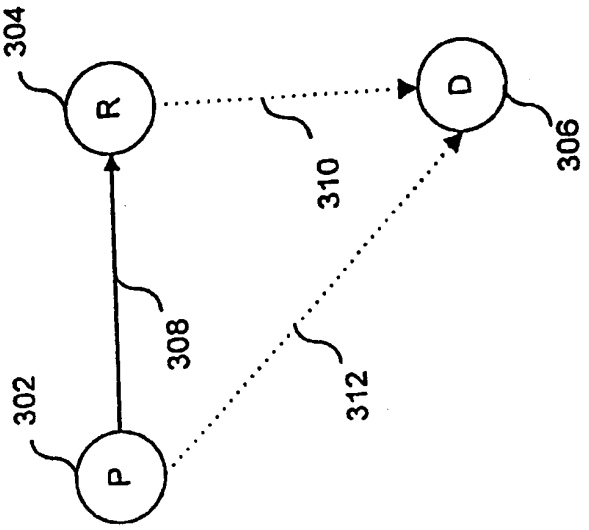


FIG.3B

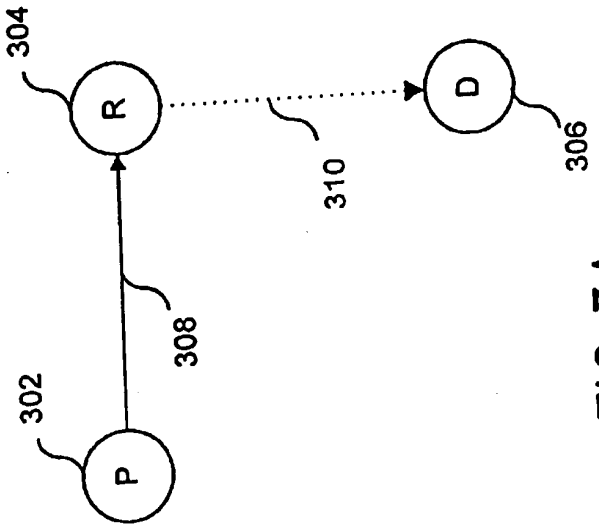


FIG.3A

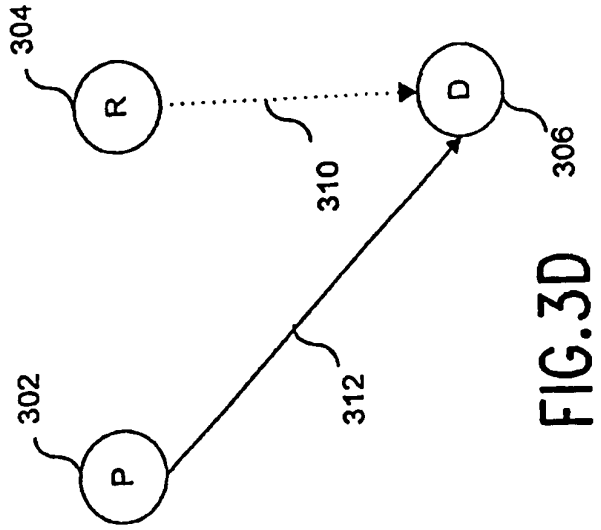


FIG.3D

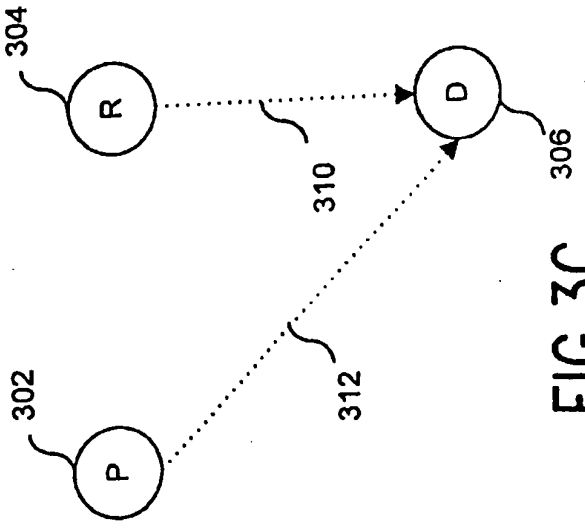


FIG.3C

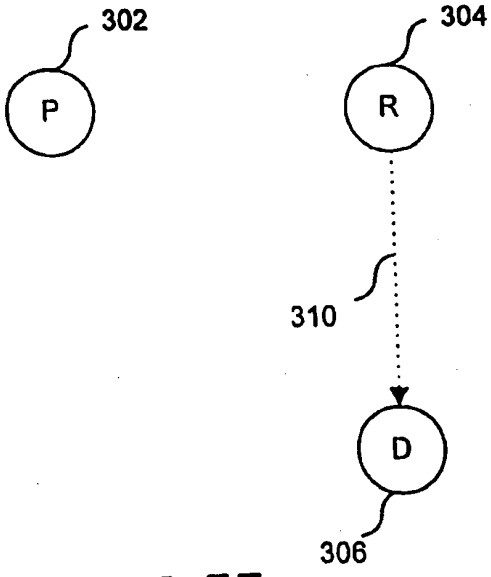


FIG.3E

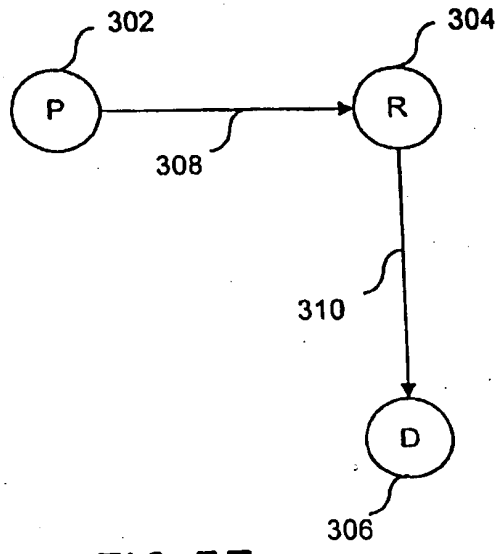


FIG.5E

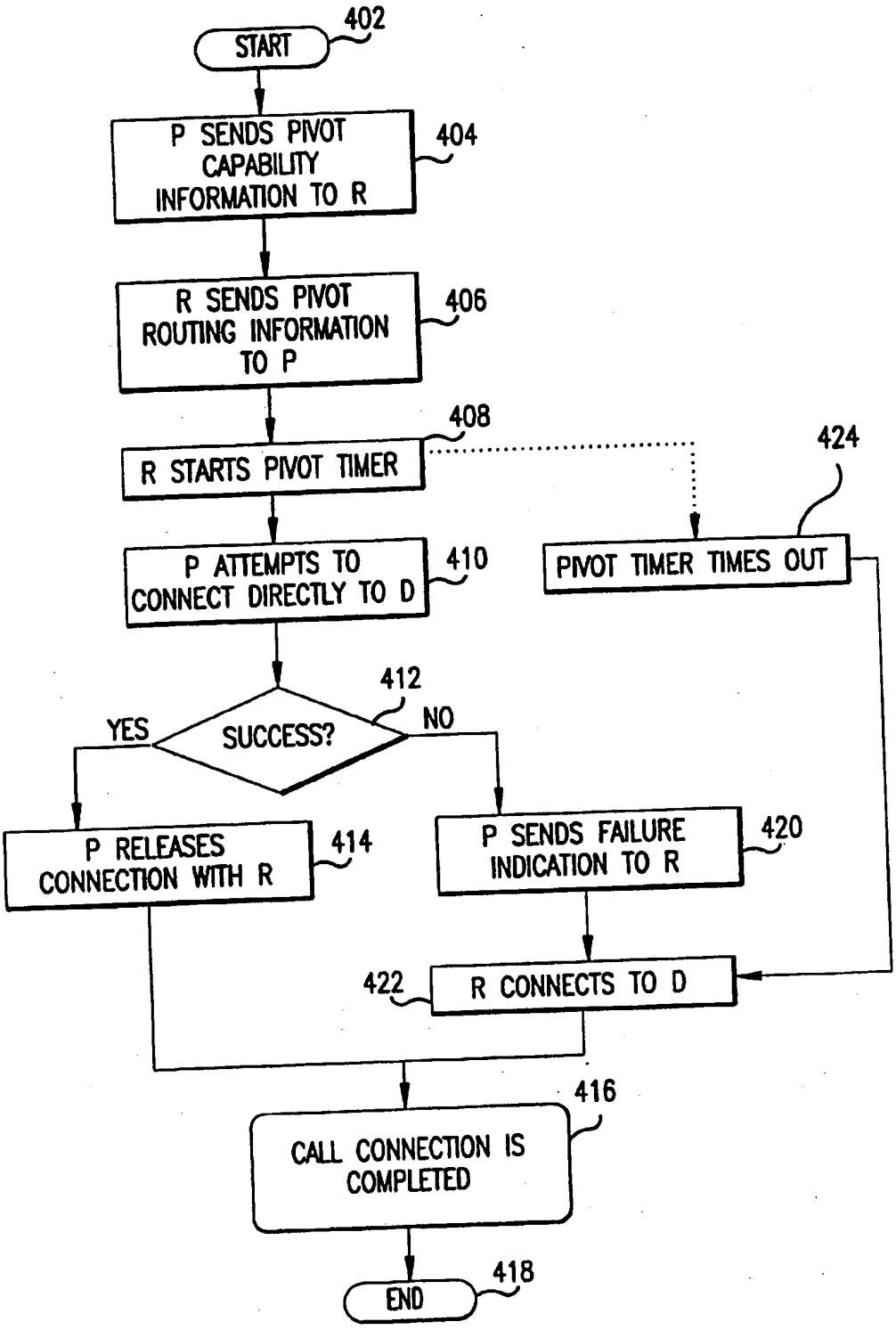

START
402
P SENDS PIVOT CAPABILITY INFORMATION TO R
404
R SENDS PIVOT ROUTING INFORMATION TO P
406
R STARTS PIVOT TIMER
408
P ATTEMPTS TO CONNECT DIRECTLY TO D
410
SUCCESS?
412
YES
NO
P RELEASES CONNECTION WITH R
414
P SENDS FAILURE INDICATION TO R
420
PIVOT TIMER TIMES OUT
424
R CONNECTS TO D
422
CALL CONNECTION IS COMPLETED
416
END
418

FIG.4

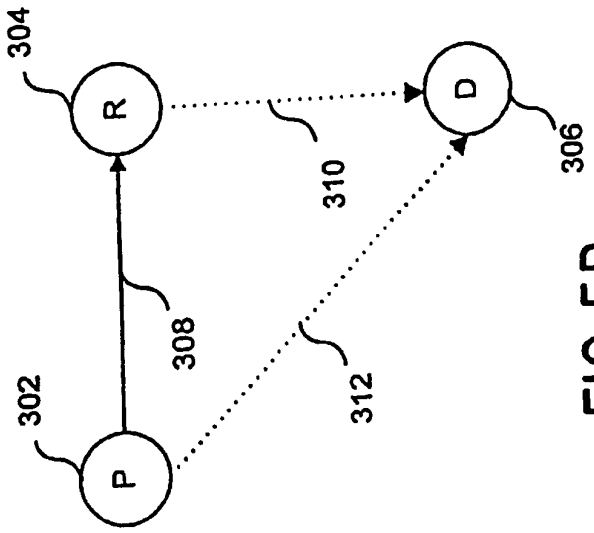


FIG.5B

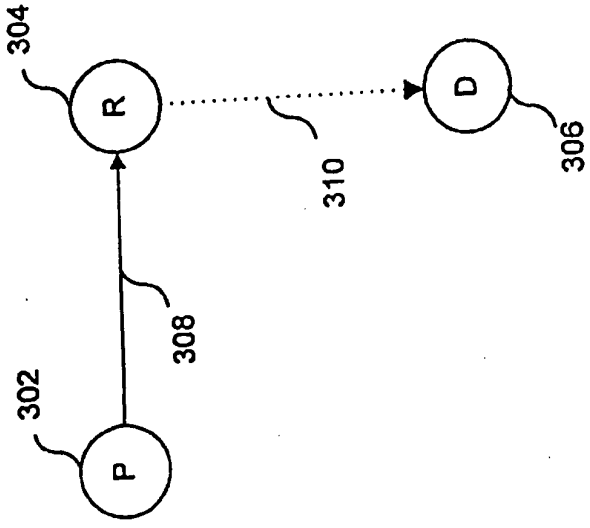


FIG.5A

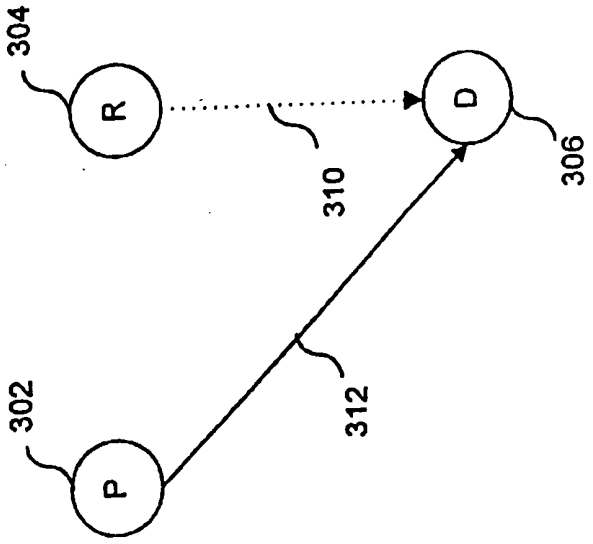


FIG.5D

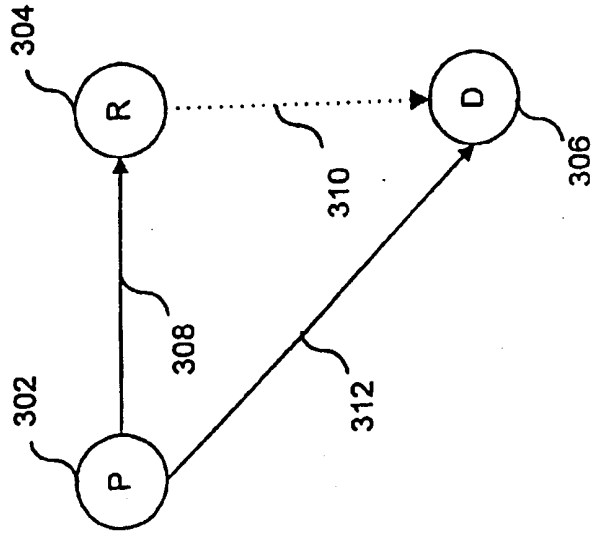


FIG.5C

SYSTEM AND METHOD FOR SAFELY AND EFFICIENTLY REDIRECTING A TELEPHONE CALL

BACKGROUND OF THE INVENTION

Related Application

This application is related to a commonly owned application, filed concurrently herewith, entitled "System and Method for Branching a Telephone Call" having application Ser. No. 08/654,296, which is incorporated herein by reference.

Field of the Invention

The present invention relates generally to systems and methods for network switching, and more particularly to efficient routing of communication paths in a telecommunications system.

Related Art

A conventional telecommunications network comprises three basic components: user terminals (for example, telephones), communications busses (also known as links; for example, telephone lines) and nodes. The nodes are used to selectively connect the user terminals via the links. A node is a functional entity employed to route a call, not a physical entity. Therefore, the correspondence between nodes and physical switches is not necessarily one-to-one.

When a connection is required from one user terminal to another (or even from one node to another), network resources are allocated to complete the connection (for example, to route a call); that is, some of the nodes are manipulated to interconnect some of the links to form a communications path between the user terminals. Because these network resources are scarce, one goal of network resource allocation is to find the communications path that involves the fewest nodes.

Often, a need will arise for a telephone call to be redirected. This may happen, for example, when a caller calls an operator to find a telephone number for a party the user wishes to call, and then the operator connects the caller to the called party. The call can then be extended via the operator to the called party. The disadvantage of this approach is that this routing may be inefficient; that is, the routing may involve more nodes than necessary. What is needed is a way to reroute the call to involve fewer nodes.

A conventional approach, known as Release to Pivot (RTP), has been developed to meet this need. In RTP, a node providing an indirect connection between two other nodes (such as the operator's node in the above example) is termed the "release" node. Of the other two nodes, the node connected, directly or indirectly, to the originating user terminal (for example, a caller's telephone) is termed the "pivot" node, and the node nearest to the terminating user terminal (for example, the telephone of the party called) is termed the "destination" node. Under the RTP scheme, when the release node determines that a direct connection may be had between the pivot and destination nodes, it releases its connection with the pivot node. The pivot node then attempts a direct connection with the destination node. If successful, the resulting connection involves only two nodes (the pivot and destination nodes), rather than three.

The principal disadvantage of the RTP scheme arises when the pivot node is not successful in its attempt to establish a direct connection with the destination node. When this happens, no connection is possible between the pivot node and the destination node because the release node has released its connection with the pivot node. Because the connection is not possible, the communications path between the user terminals cannot be completed (for example, the call is dropped).

What is needed, therefore, is a method for efficiently routing a call while ensuring the call's completion.

SUMMARY OF THE INVENTION

The present invention is a system and method for efficiently routing a call while ensuring the call's completion. The present invention is described in terms of a three-node network configuration. The node connected, directly or indirectly, to the originating user terminal of the communications path is termed the "pivot" node. The node nearest to the terminating user terminal of the communications path is termed the "destination" node. A third node, termed the "release" node, is connected to the pivot node and has a possible connection to the destination node, thereby providing a possible indirect communications path between the pivot and destination nodes. This three-node configuration can be located anywhere in a network of many nodes, as long as the three nodes are directly connected to one another as described above. Also, the connection between the pivot and release nodes, and the connection between the pivot and destination nodes, need not be direct, but may involve one or more transparent nodes.

The present invention attempts to connect the pivot and destination nodes directly. If the attempt succeeds, the communications path is shortened by one node—the release node. If the attempt fails, the original communications path—via the release node—is restored. The failure can be indicated to the release node in at least two ways. First, the pivot node can inform the release node of the failure. Second, the failure can be indicated by the expiration of a timer in the release node. When the failure is indicated, the release node completes the connection to the destination node, thereby providing a communications path from the pivot node to the destination node via the release node.

One advantage of the present invention is that it permits rerouting a communications path so as to reduce the number of nodes involved. Another advantage of the present invention is to that it permits restoration of the original communications path if the rerouting cannot be accomplished.

Further features and advantages of the present invention as well as the structure and operation of various embodiments of the present invention are described in detail below with reference to the accompanying drawings. In the drawings, like reference numbers indicate identical or functionally similar elements. Additionally, the left-most digit of a reference number identifies the drawing in which the reference number first appears.

BRIEF DESCRIPTION OF THE FIGURES

The present invention will be described with reference to the accompanying drawings, wherein:

FIG. 1 shows a typical communications network consisting of nodes connected by links;

FIG. 2 is a flowchart depicting the operation of a conventional network resource allocation mechanism known as RTP;

FIGS. 3A–3E depict a network of three nodes useful in describing the operation of a conventional mechanism;

FIG. 4 is a flowchart depicting the operation of the present invention according to a preferred embodiment; and

FIGS. 5A–5E depict the three-node network of FIG. 3, which is also useful in describing the operation of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiment of the invention is discussed in detail below. While specific steps, configurations and arrangements are discussed, it should be understood that this is done for illustrative purposes only. A person skilled in the relevant art will recognize that other steps, configurations and arrangements can be used without departing from the spirit and scope of the present invention.

The present invention is a system and method for efficiently routing a call while ensuring the call's completion. For ease of discussion, the present invention is discussed in terms of a simple three-node configuration. As will be apparent to one skilled in the relevant art, other configurations may be employed without departing from the spirit and scope of the present invention.

Before describing the operation of the present invention, an environment in which the invention may be employed is first described. FIG. **1** shows a typical communications network **100** consisting of nodes **101–105** connected by links **120–121**. The communications system **100** routes data so as to effectively interconnect data equipment **111–115** that are located at a distance from one another. This routing is accomplished within the network by the ability of each node **101** to perform one-of-many switching functions, that is, to accept data entering along one link and send the data out along a different link. Under normal circumstances, the switching within each node is directed by some overall network routing logic commonly understood by those skilled in the art.

FIG. **2** is a flowchart depicting the operation of a conventional network resource allocation mechanism known as RTP. FIGS. **3A–3E** depict a configuration of three network nodes useful in describing RTP operation. The configuration comprises "pivot" node **302**, "release" node **304**, and "destination" node **306**. Typically, pivot node **302** is connected, directly or indirectly, to an originating user terminal (not shown), and destination node **306** is to be connected, directly or indirectly, to a terminating user terminal (also not shown). According to RTP, both pivot node **302** and release node **304** support common channel signaling (CCS); destination node **306** may or may not support CCS. CCS is a method of signaling whereby the paths taken by control signals are independent of the associated communications path. CCS can be contrasted to inband signaling, where the path taken by the control signals is the same as the associated communications path. This three-node configuration can be located anywhere in a network of many nodes, as long as the three nodes are directly or indirectly connected to one another as described above.

FIG. **3A** depicts an initial stage in the connection of pivot node **302** to destination node **306**. In FIG. **3A**, connection **308** has been made between pivot node **302** and release node **304**, and a possible connection **310** has been detected between release node **304** and destination node **306**. Thus, an indirect connection is possible between pivot node **302** and destination node **306** via release node **304** using connections **308** and **310**.

FIG. **3B** depicts a further stage in the connection of pivot node **302** to destination node **306**. In FIG. **3B**, release node **304** has detected a possible direct connection **312** between pivot node **302** and destination node **306**. This stage corresponds to start step **202** in FIG. **2**.

In a step **204**, pivot node **302** sends Pivot Capability Information to release node **304**. The Pivot Capability Information indicates that pivot node **302** is capable of the RTP function. In a step **206**, release node **304** sends Pivot Routing Information to pivot node **302**. The Pivot Routing Information contains information necessary for pivot node **302** to establish connection **312** with destination node **306**; for example, the Pivot Routing Information can contain the network address of destination node **306** or the address of the terminating end user. In a step **208**, release node **304** releases its connection **308** with pivot node **302**. The resulting network configuration is shown in FIG. **3C**.

In a step **210**, pivot node **302** attempts to connect directly to destination node **306** via connection **312**. If pivot node **302** is successful in making connection **312** with destination node **306**, as indicated by the "yes" branch from step **212**, then the call connection is completed in a step **214**. The resulting network configuration is shown in FIG. **3D**.

If, however, pivot node **302** is not successful in establishing connection **312**, as indicated by the "no" branch out of step **212**, then the call is "taken down" (that is, disconnected) in a step **218**. This resulting network configuration is depicted in FIG. **3E**, which shows no connection, direct or indirect, between pivot node **302** and destination node **306**. Thus if the attempt to establish a direct connection between pivot node **302** and destination node **306** fails, the communications path is not completed (for example, the call is dropped).

FIG. **4** is a flowchart depicting the operation of the present invention, herein termed Facility Request to Pivot (FRP), according to a preferred embodiment. FIGS. **5A–5E** depict the three-node network of FIG. **3**, which is also useful in describing the operation of the present invention. As in FIG. **3**, pivot node **302** is typically connected, directly or indirectly, to an originating user terminal (not shown), and destination node **306** typically is to be connected, directly or indirectly, to a terminating user terminal (also not shown). According to a preferred embodiment of the present invention, both pivot node **302** and release node **304** support common channel signaling (CCS); destination node **306** may or may not support CCS.

FIG. **5A** depicts an initial stage in the connection of pivot node **302** to destination node **306**. In FIG. **5A**, connection **308** has been made between pivot node **302** and release node **304**, and a possible connection **310** has been detected between release node **304** and destination node **306**. Thus, an indirect connection is possible between pivot node **302** and destination node **306** via release node **304** using connections **310** and **308**.

FIG. **5B** depicts a further stage in the connection of pivot node **302** to destination node **306**. FIG. **5B** depicts a possible direct connection **312** between pivot node **302** and destination node **306**. This stage corresponds to start step **402** in FIG. **4**.

In a step **404**, pivot node **302** sends Pivot Capability Information to release node **304**. The Pivot Capability Information indicates that pivot node **302** is capable of the FRP function. In a step **406**, release node **304** sends Pivot Routing Information to pivot node **302**. The Pivot Routing Information contains the network address of destination node **306** and any other information necessary for pivot node **302** to establish connection **312** with destination node **306**.

In a step **408**, release node **304** starts a timer (herein termed the Pivot Timer). The purpose of the Pivot Timer is to notify release node **304** when a predetermined time has elapsed. As explained below, when the Pivot Timer expires, release node **304** assumes that the direct connection of pivot node **302** to destination node **306** has failed, and establishes a direct connection **310** to destination node **306**.

In a step **410**, pivot node **302** attempts to connect directly to destination node **306** via connection **312**. If the connection is successful, as indicated by the "yes" branch from step **412** and as shown in FIG. **5**C, then in a step **414**, pivot node **302** releases its connection **308** with release node **304**. Thus the call connection is completed in a step **416**, as shown in FIG. **5**D.

If, however, the connection is unsuccessful, as indicated by the "no" branch from step **412**, then in a step **420**, pivot node **302** sends a Failure Indication to release node **304**. Then in a step **422**, release node **304** establishes connection **310** to destination node **306**. Thus, the call connection is completed between pivot node **302** and destination node **306** via release node **304** and connections **308** and **310** as shown in a step **416** and in FIG. **5**E.

Alternatively, if the connection is unsuccessful but release node **304** receives no Failure Indication, release node **304** will proceed with indirect routing when the Pivot Timer expires, as shown in a step **424**. When this happens, the release node **304** completes connection **310** to destination node **306**, and in a step **416**, the call connection is completed, as shown in FIG. **5**E.

Thus, according to the present invention, even though the direct connection between pivot node **302** and destination node **306** fails, an indirect connection via release node **304** is completed, and therefore the call communications path is completed (for example, a call is completed).

While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example, and not limitation. It will be apparent to persons skilled in the relevant art that various changes in form and detail can be made therein without departing from the spirit and scope of the invention. Thus the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. In a communications network, a system for efficiently routing communications from an originating user terminal to a terminating user terminal, comprising:

a destination node to be connected to the terminating user terminal;

a pivot node, connected to the originating user terminal, for attempting to establish a direct connection to said destination node;

a release node, connected to said pivot node and having a possible connection to said destination node, for establishing a direct connection to said destination node if said pivot node is unsuccessful in establishing said direct connection to said destination node; and

means for releasing the connection between said pivot node and said release node if said destination node and said pivot node can be connected directly.

2. The system of claim **1**, wherein said release node sends information to said pivot node to enable said pivot node to attempt to establish a direct connection with said destination node.

3. The system of claim **1**, wherein said pivot node comprises means for sending a failure indication to said release node.

4. The system of claim **2**, wherein said release node comprises a timer, said timer started when said release node sends said information to said pivot node, wherein said failure is indicated by the expiration of said timer.

5. In a communications network having a pivot node, a destination node, and a release node, the release node connected to the pivot node and having a possible connection to the destination node, a system for attempting to replace an indirect communications path from the pivot node to the destination node via the release node with a direct communications path from the pivot node to the destination node, comprising:

means for attempting to establish a direct connection between the destination node and the pivot node;

means for establishing a direct connection between the destination node and the pivot node and releasing the connection between the pivot node and the release node if the destination node and the pivot node can be connected directly; and

means for establishing a direct connection between the destination node and the release node if the destination node and the pivot node cannot be connected directly.

6. The system of claim **5**, further comprising:

means for sending information from the release node to the pivot node to enable the pivot node to attempt to establish a direct connection with the destination node.

7. The system of claim **5**, further comprising means for sending a failure indication from the pivot node to the release node.

8. The system of claim **6**, further comprising:

means for starting a timer when said information is sent; and

means for connecting the destination node to the release node when said timer expires.

9. In a communications network having a pivot node, a destination node, and a release node, the release node connected to the pivot node and having a possible connection to the destination node, a method for attempting to replace an indirect communications path from the pivot node to the destination node via the release node with a direct communications path from the pivot node to the destination node, comprising the steps of:

(1) attempting to establish a direct connection between the destination node and the pivot node;

(2) if the destination node and the pivot node can be connected directly, establishing a direct connection between the destination node and the pivot node and releasing the connection between the pivot node and the release node; and

(3) if the destination node and the pivot node cannot be connected directly, establishing a direct connection between the destination node and the release node.

10. The method of claim **9**, further comprising the step of sending information from the release node to the pivot node to enable the pivot node to attempt to establish a direct connection with the destination node.

11. The system of claim **9**, further comprising the step of sending a failure indication from the pivot node to the release node.

12. The method of claim **10**, further comprising the steps of:

starting a timer when said information is sent; and

connecting the destination node to the release node when said timer expires.

* * * * *